WHAT IS CLAIMED IS:

1.   A reproducing apparatus comprising:

first means for reproducing a signal representative of digital

5   information from a recording medium;

second means for sampling the signal reproduced by the first means

in response to a clock signal to generate a sampling-resultant signal;

third means for subjecting the sampling-resultant signal to a

re-sampling process and an interpolation process responsive to timing

10   information to generate a re-sampling-resultant signal;

fourth means for deciding whether the re-sampling-resultant signal

is in a continuous-wave interval where an inversion period of the

re-sampling-resultant signal remains constant or in a random-wave

interval where the inversion period of the re-sampling-resultant signal

15   varies at random;

fifth means for extracting a first value of the re-sampling-resultant

signal at a time point corresponding to every zero-cross timing, for

controlling a polarity of the extracted first value in response to whether the

re-sampling-resultant signal is rising or falling in value to generate a

20   polarity-control-resultant value, and for generating a first phase error in

response to the polarity-control-resultant value;

sixth means for repetitively extracting a second value of the

re-sampling-resultant signal at a constant period corresponding to a

normal inversion period occurring during the continuous-wave interval, for

25   alternately changing a polarity of the extracted second value between

positive and negative to generate a polarity-change-resultant value, and for

generating a second phase error in response to the

polarity-change-resultant value;

seventh means for selecting the first phase error generated by the fifth means when the fourth means decides that the re-sampling-resultant signal is in a random-wave interval, and for selecting the second phase error generated by the sixth means when the fourth means decides that the

5   re-sampling-resultant signal is in a continuous-wave interval;

a loop filter for integrating the phase error selected by the seventh means to generate a phase-error integration result; and

eighth means for generating the timing information in response to the phase-error integration result generated by the loop filter.

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2.   A reproducing apparatus comprising:

first means for reproducing a signal representative of digital information from a recording medium;

second means for sampling the signal reproduced by the first means

15   in response to a clock signal to generate a sampling-resultant signal;

third means for deciding whether the sampling-resultant signal is in a continuous-wave interval where an inversion period of the sampling-resultant signal remains constant or in a random-wave interval where the inversion period of the sampling-resultant signal varies at

20   random;

fourth means for extracting a first value of the sampling-resultant signal at a time point corresponding to every zero-cross timing, for controlling a polarity of the extracted first value in response to whether the sampling-resultant signal is rising or falling in value to generate a

25   polarity-control-resultant value, and for generating a first phase error in response to the polarity-control-resultant value;

fifth means for repetitively extracting a second value of the sampling-resultant signal at a constant period corresponding to a normal

inversion period occurring during the continuous-wave interval, for alternately changing a polarity of the extracted second value between positive and negative to generate a polarity-change-resultant value, and for generating a second phase error in response to the

5   polarity-change-resultant value;

sixth means for selecting the first phase error generated by the fourth means when the third means decides that the sampling-resultant signal is in a random-wave interval, and for selecting the second phase error generated by the fifth means when the third means decides that the

10   sampling-resultant signal is in a continuous-wave interval; and

seventh means for generating the clock signal in response to the phase error selected by the sixth means.

3.   A reproducing apparatus as recited in claim 1, wherein the fourth

15   means comprises:

means for deciding whether or not a latest inversion period Y of the re-sampling-resultant signal satisfies one of relations as follows:

$$X - 1 \leq Y \leq X + 1$$
$$X - 2 \leq Y \leq X$$

20     $$X \leq Y \leq X + 2$$

where X denotes the normal inversion period occurring in the continuous-wave interval;

means for deciding whether or not the latest inversion period Y consecutively satisfies one of the relations a prescribed number of times;

25   and

means for deciding that the re-sampling-resultant signal is in a continuous-wave interval when the latest inversion period Y consecutively satisfies one of the relations the prescribed number of times.

4.   A reproducing apparatus as recited in claim 1, wherein the fourth means comprises:

means for detecting a latest period Z for which the

5   re-sampling-resultant signal either rises or falls;

means for deciding whether or not the latest period Z satisfies one of relations as follows:

$$2X - 1 \leqq Z \leqq 2X + 1$$

$$2X - 2 \leq Z \leqq 2X$$

10    $$2X \leq Z \leqq 2X + 2$$

where X denotes the normal inversion period occurring in the continuous-wave interval;

means for deciding whether or not the latest period Z consecutively satisfies one of the relations a prescribed number of times; and

15   means for deciding that the re-sampling-resultant signal is in a continuous-wave interval when the latest period Z consecutively satisfies one of the relations the prescribed number of times.

5.   A reproducing apparatus as recited in claim 1, wherein the fourth

20   means comprises:

means for deciding whether or not a latest inversion period of the re-sampling-resultant signal exceeds a preset period; and

means for controlling the seventh means to select the first phase error when it is decided that the latest inversion period of the

25   re-sampling-resultant signal exceeds the preset period.

6.   A reproducing apparatus comprising:

first means for reproducing a signal representative of digital

information from a recording medium;

second means for sampling the signal reproduced by the first means in response to a clock signal to generate a sampling-resultant signal;

third means for deciding whether the sampling-resultant signal is in
5   a specified-pattern repetition interval where an inversion period of the sampling-resultant signal changes in accordance with a repetition of a specified pattern or in a random-wave interval where the inversion period of the sampling-resultant signal varies at random;

fourth means for extracting a first value of the sampling-resultant
10   signal at a time point corresponding to every zero-cross timing, for controlling a polarity of the extracted first value in response to whether the sampling-resultant signal is rising or falling in value to generate a first polarity-control-resultant value, and for generating a first phase error in response to the first polarity-control-resultant value;

15   fifth means for repetitively extracting a second value of the sampling-resultant signal at a period changing in accordance with the specified pattern, for controlling a polarity of the extracted second value in response to whether the extracted second value is in a value-rising time or a value-falling time to generate a second polarity-control-resultant value, and
20   for generating a second phase error in response to the second polarity-control-resultant value;

sixth means for selecting the first phase error generated by the fourth means when the third means decides that the sampling-resultant signal is in a random-wave interval, and for selecting the second phase
25   error generated by the fifth means when the third means decides that the sampling-resultant signal is in a specified-pattern repetition interval; and

seventh means for generating the clock signal in response to the phase error selected by the sixth means.

7.   A reproducing apparatus comprising:

first means for reproducing a signal representative of digital information from a recording medium;

5   second means for sampling the signal reproduced by the first means in response to a clock signal to generate a sampling-resultant signal;

third means for subjecting the sampling-resultant signal to a re-sampling process and an interpolation process responsive to timing information to generate a re-sampling-resultant signal;

10   fourth means for deciding whether the re-sampling-resultant signal is in a specified-pattern repetition interval where an inversion period of the re-sampling-resultant signal changes in accordance with a repetition of a specified pattern or in a random-wave interval where the inversion period of the re-sampling-resultant signal varies at random;

15   fifth means for extracting a first value of the re-sampling-resultant signal at a time point corresponding to every zero-cross timing, for controlling a polarity of the extracted first value in response to whether the re-sampling-resultant signal is rising or falling in value to generate a first polarity-control-resultant value, and for generating a first phase error in

20   response to the first polarity-control-resultant value;

sixth means for repetitively extracting a second value of the re-sampling-resultant signal at a period changing in accordance with the specified pattern, for controlling a polarity of the extracted second value in response to whether the extracted second value is in a value-rising time or a

25   value-falling time to generate a second polarity-control-resultant value, and for generating a second phase error in response to the second polarity-control-resultant value;

seventh means for selecting the first phase error generated by the

fifth means when the fourth means decides that the re-sampling-resultant

signal is in a random-wave interval, and for selecting the second phase

error generated by the sixth means when the fourth means decides that the

re-sampling-resultant signal is in a specified-pattern repetition interval;

5   a loop filter for integrating the phase error selected by the seventh

means to generate a phase-error integration result; and

eighth means for generating the timing information in response to

the phase-error integration result generated by the loop filter.

10   8.   A reproducing apparatus as recited in claim 6, wherein the third

means comprises:

means for deciding whether or not a latest inversion period $Y(i)$ of the

sampling-resultant signal satisfies one of relations as follows:

$Y(i-J) - 1 \leq Y(i) \leq Y(i-J) + 1$

15   $Y(i-J) - 2 \leq Y(i) \leq Y(i-J)$

$Y(i-J) \leq Y(i) \leq Y(i-J) + 2$

where J denotes a number of inversion period elements composing the

specified pattern;

means for deciding whether or not the latest inversion period $Y(i)$

20   consecutively satisfies one of the relations a prescribed number of times;

and

means for deciding that the sampling-resultant signal is in a

specified-pattern repetition interval when the latest inversion period $Y(i)$

consecutively satisfies one of the relations the prescribed number of times.

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9.   A reproducing apparatus as recited in claim 6, wherein the third

means comprises:

means for deciding whether or not a latest inversion period $Z(i+k)$ of

the sampling-resultant signal satisfies one of relations as follows:

$$X(k) - 1 \leq Z(i+k) \leq X(k) + 1$$

$$X(k) - 2 \leq Z(i+k) \leq X(k)$$

$$X(k) \leq Z(i+k) \leq X(k) + 2$$

5   where X(k) denotes one among inversion period elements composing the specified pattern;

means for deciding whether or not the latest inversion period Z(i+k) consecutively satisfies one of the relations a prescribed number of times; and

10   means for deciding that the sampling-resultant signal is in a specified-pattern repetition interval when the latest inversion period Z(i+k) consecutively satisfies one of the relations the prescribed number of times.

10.   A reproducing apparatus as recited in claim 6, wherein the third

15 means comprises:

means for deciding whether or not a latest inversion period Y(i+1) and a second latest inversion period Y(i) of the sampling-resultant signal satisfy one of relations as follows:

$$Y(i) \bullet 2 < Y(i+1)$$

20         $$Y(i) > Y(i+1) \bullet 2;$$

where the character "•" denotes product; and

means for starting the decision about whether the sampling-resultant signal is in a specified-pattern repetition interval or a random-wave interval when it is decided that the latest inversion period

25 Y(i+1) and the second latest inversion period Y(i) satisfy one of the relations.

11.   A reproducing apparatus as recited in claim 6, wherein the third means comprises:

means for measuring a time interval for which the sampling-resultant signal remains in a specified-pattern repetition interval; and

means for controlling the sixth means to select the first phase error

5   when the measured time interval reaches a predetermined time value.

12.   A reproducing apparatus as recited in claim 6, wherein the specified pattern includes a succession of inversion periods as 5T•5T•3T•3T•2T•2T, where T denotes a bit period of the digital information.

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13.   A reproducing apparatus as recited in claim 1, wherein the third means, the fifth means, the sixth means, the seventh means, the loop filter, and the eighth means compose a feedback loop, and further comprising means for changing a loop gain of the feedback loop in response to which of

15   the first phase error and the second phase error is selected by the seventh means.

14.   A reproducing apparatus as recited in claim 6, wherein the sixth means comprises means for selecting only the second phase error which

20   corresponds to an inversion period longer than a prescribed period.

15.   A reproducing apparatus as recited in claim 1, wherein the seventh means comprises:

means for measuring a time interval for which the second phase

25   error remains selected; and

means for selecting the first phase error instead of the second phase error when the measured time interval reaches a predetermined time value.

16.   A computer program used for a reproducing apparatus comprising
first means for reproducing a signal representative of digital information
from a recording medium, second means for sampling the signal
reproduced by the first means in response to a clock signal to generate a

5   sampling-resultant signal, and a computer, the computer program enabling
the computer to operate as:

third means for deciding whether the sampling-resultant signal is in
a continuous-wave interval where an inversion period of the
sampling-resultant signal remains constant or in a random-wave interval

10   where the inversion period of the sampling-resultant signal varies at
random;

fourth means for extracting a first value of the sampling-resultant
signal at a time point corresponding to every zero-cross timing, for
controlling a polarity of the extracted first value in response to whether the

15   sampling-resultant signal is rising or falling in value to generate a
polarity-control-resultant value, and for generating a first phase error in
response to the polarity-control-resultant value;

fifth means for repetitively extracting a second value of the
sampling-resultant signal at a constant period corresponding to a normal

20   inversion period occurring during the continuous-wave interval, for
alternately changing a polarity of the extracted second value between
positive and negative to generate a polarity-change-resultant value, and for
generating a second phase error in response to the
polarity-change-resultant value;

25   sixth means for selecting the first phase error generated by the
fourth means when the third means decides that the sampling-resultant
signal is in a random-wave interval, and for selecting the second phase
error generated by the fifth means when the third means decides that the

sampling-resultant signal is in a continuous-wave interval; and

seventh means for generating the clock signal in response to the phase error selected by the sixth means.

5   17.   A computer program used for a reproducing apparatus comprising first means for reproducing a signal representative of digital information from a recording medium, second means for sampling the signal reproduced by the first means in response to a clock signal to generate a sampling-resultant signal, and a computer, the computer program enabling

10   the computer to operate as:

third means for deciding whether the sampling-resultant signal is in a specified-pattern repetition interval where an inversion period of the sampling-resultant signal changes in accordance with a repetition of a specified pattern or in a random-wave interval where the inversion period of

15   the sampling-resultant signal varies at random;

fourth means for extracting a first value of the sampling-resultant signal at a time point corresponding to every zero-cross timing, for controlling a polarity of the extracted first value in response to whether the sampling-resultant signal is rising or falling in value to generate a first

20   polarity-control-resultant value, and for generating a first phase error in response to the first polarity-control-resultant value;

fifth means for repetitively extracting a second value of the sampling-resultant signal at a period changing in accordance with the specified pattern, for controlling a polarity of the extracted second value in

25   response to whether the extracted second value is in a value-rising time or a value-falling time to generate a second polarity-control-resultant value, and for generating a second phase error in response to the second polarity-control-resultant value;

sixth means for selecting the first phase error generated by the fourth means when the third means decides that the sampling-resultant signal is in a random-wave interval, and for selecting the second phase error generated by the fifth means when the third means decides that the

5   sampling-resultant signal is in a specified-pattern repetition interval; and

seventh means for generating the clock signal in response to the phase error selected by the sixth means.

18.   A reproducing apparatus as recited in claim 1, further comprising:

10   ninth means for recovering the digital information from the re-sampling-resultant signal;

tenth means for deciding whether or not a sync signal regularly appears in the recovered digital information; and

eleventh means for forcing the seventh means to select the first

15   phase error when the tenth means decides that a sync signal regularly appears in the recovered digital information.

19.   A reproducing apparatus as recited in claim 6, further comprising:

eighth means for recovering the digital information from the

20   sampling-resultant signal;

ninth means for deciding whether or not a sync signal regularly appears in the recovered digital information; and

tenth means for forcing the sixth means to select the first phase error when the ninth means decides that a sync signal regularly appears in

25   the recovered digital information.